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ABSTRACT

Guidelines for the planning and purchase of microcomputer systems are presented in outline form. These guidelines are directed to educators in developmental education, special education, and learning center environments; however, they are applicable to all educators intending to use microcomputers. First, a discussion of hardware considerations is presented. Guidelines for selecting a computer are offered, focusing on business/office and educational uses and the computer configuration. Information on chip type, stand-alone and mainframe terminals, and shared storage and communication is included. Suggestions are also outlined related to the following: maintenance, supplies, security, furniture, cables, and construction. A discussion of peripherals is presented, including input devices, such as the keyboard, numeric key pad, disk drive, tape recorder, game paddle, graphics tablet, touch screen, light pen, scientific instruments, optical mark reader, and microphone; output devices, such as the screen, printer, and speaker; communication devices, such as the multiplexer and modem; and interface boards. Next, considerations in software selection are addressed, including the learning characteristics of developmental students, the unique properties of the computer, and conditions of learning. Finally, a planned approach to using microcomputers in the learning center is outlined. (LAL)

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MICROCOMPUTERS IN THE LEARNING CENTER:
GUIDELINES FOR AVOIDING COSTLY MISTAKES

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ABSTRACT:

The author proposes guidelines for the planning and purchase of microcomputer hardware and software. Although these guidelines are directed to Developmental Education, Special Education, and Learning Center environments, educators intending to use microcomputers for any purpose will find them useful.

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HARDWARE CONSIDERATIONS

I. The Computer

A. Use

1. Business/Office: Does the amount of business use warrant a machine dedicated to that purpose? Word processing? Keep in mind that the best business software often uses different microprocessors (chips) than the best educational software. Software that runs on Apple computers, for example, will not run on IBM's without expensive peripheral circuit boards.
2. Education: Ideally, the software you need should dictate the hardware you buy. Determine the purpose you will be using the computers for, identify the best software to accomplish those purposes, and buy the type of computer that will run that software. Price should NOT be a major determinant, especially for a few hundred dollars. Buy a computer that has a wide variety of software available for it, one that has accessible service centers, and one that will be around for a while. Some content areas will require special hardware (graphics tablets, printers, scientific instruments, music keyboards, and the like). Will your computer be able to handle these equipment loads?

- B. Configuration: Do you want your computer to talk with other computers on your campus, or to work in a stand-alone capacity? What languages must your computer understand to talk with other computers? What will the modem requirements be? What form must the outgoing and incoming signals take? How fast can information be transmitted? Will your computer be able to fulfill these requirements? (See below for a more detailed discussion of these topics.)

1. Chip Type -- 8, 16, 32 bit: Bigger is better and faster, but is there enough software out there to meet your needs on the larger chips. Most instructional programs have been written for 8-bit chips. Remember -- you don't need state of the art equipment to have a very good microcomputing facility.
2. Stand-Alone: Not linked to another computer.
3. Main-Frame Terminal
 - a. Dumb Terminal: This is a terminal that will only receive information from or send information to a "parent" computer. If you want to manipulate data at the terminal site this may not be an acceptable option.
 - b. Intelligent Terminal: One which will process information at the terminal site.

4. Network

- a. Shared Storage: This is usually a hard disk drive that several computers are hooked to. A device that acts as a "traffic cop" in regulating incoming and outgoing signals is necessary, as are appropriate switch boxes to shunt signals from one location to another. (Some options limit placement of the computer to close proximity of the hard disk drive.) Obtaining software for such systems is difficult at times. To load a program onto a hard disk means that you must purchase programs that are not protected from copying (often of poor quality), arrange to buy unprotected copies of a program at substantially higher cost, or break copyright laws by "cracking" the protection scheme so that you can copy the program. Such a system is faster than one with floppy disks, less susceptible to accidental or malicious disk damage, more efficient in terms of disk storage, and cheaper in the long run since multiple copies of programs are not necessary. This option should be seriously considered if you intend to have eight or more microcomputers in the Learning Center.
- b. Communications: This usually means having a microcomputer "talk" to another computer (electronic mail, accessing remote data bases, and the like). There are still many problems with microcomputers in this area. Some popular magazines ("InfoWorld", "Popular Computing") have carried articles on this topic within the last six months. Talk to someone knowledgeable in the field before deciding on this capability.

II. Important Miscellaneous

A. Maintenance

1. Preventative: Budget for "dusting and cleaning" operations on ALL equipment. This should occur at least annually, depending on the amount of use a given piece of equipment gets.
2. Service Contract: I have not found service contracts to be cost effective for all equipment. However, you may want to consider this option for hardware that has many moving parts and undergoes a substantial amount of bumping and shaking -- printers and disk drives in particular. Routine maintenance on these items should be done more often than on the monitor or computer.

B. Supplies

1. Paper: What size do you need? Spreadsheet print-outs usually require wider paper than that used for word processing print-outs. Will you need mailing labels? Index cards? What grade of paper will suit your purposes? A heavier weight is more suitable for correspondence; rough drafts of compositions could be printed on paper of lesser quality. Will you want your correspondence on fan-folded paper (this will have perforation marks on the edges) or on separate sheets? Also, poorer quality paper will produce more paper dust and will cause more wear and tear on your printer. Green and white lined paper is useful when you need to read reports that have many columns and rows.
2. Floppy Disks: Buy at least half again as many as you project you'll need. Remember, you need disks for back-up and you'll want to back up three deep on important items.
3. Disk Storage: Budget for Roll-A-Dex holders, ring binders or disk trays.
4. Manuals, Magazines, Books: Budgeting for these items will allow you to remain current with new products appearing on the scene.

C. Security

1. Room: A secure lock and door are a necessity.
2. Machine & Peripheral: A device that limits access to the interface boards and which you can attach the computer, disk drives and monitor will prevent damage caused by idle curiosity and ignorance. This device should be affixed to the surface of the computer work station.

D. Furniture: Don't be taken in by the pictures in the ads! Are height and depth acceptable? Is there enough surface area to put your work after you've placed the equipment on the work station? A place to store disks and manuals? Can the paper get to the printer easily without drag? Is there a slot in the printer stand for bottom-feeding printers? Will the cables clutter up or lessen the work area?

E. Cables: Will it cost extra to arrange the cables so that people will not trip over them, or so they won't be unsightly? If you plan to have two computers attached to one printer you will need three cables -- one from each computer to a signal switching device and one from that device to the printer. Similar situations will arise whenever you have one peripheral serving more than one computer. Measure the length of cable you will need (around corners, down walls, and the like); longer cables are more expensive.

F. Construction

1. **Electrical:** Are there enough outlets to accomodate plugs from the computers, the monitors, the printers, cooling fans, hard disk drives, signal switching devices, and the like? Do you have grounded outlets? Do you need to install any special circuits or circuit breakers or voltage surge regulators?
2. **Carpentry:** Will you need to build work stations? Shelving for larger peripherals such as graphics tablets, printers and switch boxes or for books, manuals and magazines? Do you need to build a place to store your disks and paper? Will you need troughs to hold the cables?

III. Peripherals

A. Input Devices

1. **Keyboard:** Full stroke typewriter style keyboards are a must.
2. **Numeric Key Pad:** Valuable if you are entering large amounts of numeric data.
3. **Disk Drive**
 - a. **Floppy:** At least one computer should be equipped with two disk drives.
 - b. **Hard:** Advantages are more speed and more storage area; disadvantage is cost and availability of instructional software that can be loaded onto the hard disk. Very valuable for keeping administrative or instructional records.
4. **Tape Recorder:** Very slow and cumbersome. For all intents, tape recorders are obsolete as Input/Output (I/O) devices.
5. **Game Paddle, Joystick, Mouse:** Valuable for some games and for graphics. Probably not necessary for most instructional purposes.
6. **Graphics Tablet:** Indispensable if you intend to use the computer's graphics capabilities.
7. **Touch Screen, Blackboard:** Pressure or heat sensitive devices that will probably go the way of the Stanley Steamer.
8. **Light Pen, Bar Wand:** The former inputs data directly from the screen and is useful with young children and no.-readers (newly arrived international students?); the latter is useful for reading UPC symbols and has library and inventory applications.
9. **Scientific Instruments:** Getting numeric and graphic data directly from instrument readings in the lab eliminates much of the tedium from scientific calculations. Be prepared to fight the same battle that proponents of calculator use in math classes fought with conservative math faculty.
10. **Optical Mark Reader:** Great for grading objective tests, surveys (retention committees will love it!), statistics classes, and others of this ilk.

11. Microphones: Voice input is a much more natural way of communicating with a machine than any of the methods described above. Unfortunately the state of the art is such that vocabulary is very limited and recognition of speech patterns is not flexible. At present voice input is restricted to voice imprints of specific vocabulary words. The computer's memory limits the number of vocabulary words that can be used and it will respond only to the voice that "trained" it to recognize those words. The computer must be "retrained" every time a new speaker wants to use the voice input program. Speakers must be very careful to be consistent in their speech patterns; normal fluctuations in intonation, loudness or pitch may prevent a valid word spoken by the "trainer" from being recognized. Also keep in mind that microcomputers cannot yet make syntactic or semantic judgements; thus, state of the art voice input is in the form of single words rather than sentences. I do not believe that this is a cost effective input option at present, but the near future will very definitely see improvements that will make this an important input mode. If you are buying with an eye toward future expansion, this is an option you would want to keep open (ie, it will require a computer with a large memory).

B. Output Devices

1. Screen

a. TV

- i. R/F Modulators: TV signals are different than computer signals. A monitor can "understand" a computer signal, but a TV cannot. To allow a computer signal to be read by a TV you need to modify it. The R/F modulator does this.
- ii. Resolution: TV's produce a poorer quality picture than monitors do. Color TV's are worse than black and white ones. If you will be reading text off of the screen, you will be much better off with a monitor.
- iii. Large Screen or Projection TV's: Resolution is poorer here than on smaller screens, but if you will be using the computer in such a way that many people must read one screen (a classroom or lecture aid), this would be a valuable option to have.

b. Monitor

- i. Monochromatic: These can come as black and white, green and white, and amber and white. Get one that is easy on the eyes.
- ii. Color: (1) This is necessary only if you are running programs that have good graphics components that will lose much of their effect if presented without color. For example, on one of our biology programs it is nearly impossible to interpret the diagrams without color to enhance the pictures. (2) Pictures on a video display are produced in a fashion similar to the way newspaper photographs are made -- many small dots (called "pixels") are packed together in varying density. The closer the dots are (the denser the dot matrix) the better the quality of the picture produced. Low resolution (Lo-Res) graphics are made by a matrix on the screen approximately 40 pixels horizontally and 40 vertically. High resolution screens commonly use a matrix approximating 280 by 280. There are also monitors which use 512 by 512 or even 1024 by 1024 matrices, but the better the resolution the more expensive the monitor. (3) Many people are interested in getting 80 characters per line displayed on the screen for word processing purposes (many computers display only 40 characters across). This has little to do with the monitor; instead it is a function of the computer and the word processing software. Check with hardware and software representatives to determine what you need to get this option; (4) if you intend to display 80 characters per line on a color monitor for word processing, be sure to see it demonstrated before you buy -- the display may not be readable.
- iii. RGB: This type of color monitor produces excellent quality resolution. It is suitable for text output as well as graphics, but it is significantly more expensive than a regular color monitor.

2. Printer

a. Print Head

- i. Letter Quality: Characters are formed by a single stroke as in a typewriter; different styles of type are available. The print speed is slow and the printer may not do graphics. The printer is fairly noisy, too, so a cover to reduce noise is recommended.
- ii. Dot Matrix: Characters are formed by small dots of ink placed in a given pattern -- the closer the dots are together (ie, the denser the dot matrix) the better the quality of print and the slower the print speed. Even at their slowest, dot matrix printers are much faster than letter quality printers. They will print graphics as well as text. These are very noisy instruments and noise reduction covers are recommended for health reasons as well as for instructional ones.
- iii. Thermal: These are cheap, quiet, and slow. They also have lousy print quality and use expensive paper; I wouldn't recommend this type of printer unless price is an overriding concern.
- iv. Ink Jet: Extremely fast, excellent print quality, quiet, and exorbitantly expensive -- probably out of the realm of possibility for educational use.
- v. Laser: The same as the ink jet printer but less expensive and getting cheaper. In the near future this will probably be the printer to buy.

b. Paper Feed

- i. Pins: Sprockets are attached to the platen of the printer to drive computer paper with sprocket holes; because the sprockets are attached to the platen the printer will accomodate only one paper width.
- ii. Tractor: Similar to pin feed except the sprockets are usually attached to a rack that fits above the platen; thus, the sprockets are free to travel back and forth and the printer will be able to accomodate various paper widths.
- iii. Friction: Similar to a typewriter; can accomodate various paper widths; when using fan-fold computer paper it is critical that the paper be aligned perfectly -- otherwise you will find the side margins of your longer print-outs straying to one side of the paper.

- c. Paper Width Range: What will you be printing? Program listings and spread sheets almost require 14 7/8 inch paper width; correspondence and compositions, 8 1/2 inch; mailing labels, 3 x 5 cards, and the like use even narrower widths. If you select a printer that can use only one paper width you may be limiting the uses to which the computer can be put.
- d. Attachments
 - i. Tractor: See above.
 - ii. Sheet Feed: If you use fan-fold paper you will have perforation marks on the edges of the paper. If it is important for you to have "clean" edges on your paper and you produce so many copies that feeding individual sheets into the printer by hand is not feasible, consider buying a sheet-feed attachment.
 - iii. Buffer: Usually, while a printer is working the computer is not available for other tasks. If you don't want the computer tied up while the printer is working, consider buying an external buffer. This is basically a memory box to which your document can be transferred. Thus, the printer will pull the document out of the buffer, not out of the computer's memory, freeing up the computer to work on another task. (Most printers have a buffer built into them, but often this buffer is not large enough to store the entire document being printed.) This option becomes more attractive the more printing you do, the fewer computers you have, and the more tasks you want to do on the computer.
 - iv. Switch Box: You need a "traffic cop" whenever you have more than one machine going to the same printer. The switch box is necessary to prevent two computers from attempting to access the printer at one time.

3. Speaker

- a. Music: If you intend to use the computer as a synthesizer, you'll need speakers as output devices.
- b. Voice: Voice output is of two types: phonemic and whole word. Phonemic is very hard to understand and whole word is very limited in the size of the output vocabulary available.

C. Communications Devices

1. Multiplexer, Spooler: These are the hardware devices that permit you to connect more than one computer to a peripheral device.
2. Modem: This device enables computer signals to be converted to phone signals so that a computer can "talk" to another computer or data base over normal phone lines. Whether or not the two computers will be able to understand each other depends on several factors related to the signal characteristics (see below).

a. Connection

- i. Direct: The phone line plugs directly into the modem the way you would plug your phone into a jack. The phone receiver is bypassed entirely.
- ii. Acoustic: The receiver of the phone fits into a device that comes with the modem. Compared to a direct-connect modem, the computer signals are not as rapid or as clear.

b. Signal

- i. Half Duplex: Signals can be transmitted in only one direction on the phone line at a time.
- ii. Full Duplex: Signals can be transmitted in both directions on the phone line simultaneously.

- c. Baud Rate: A number that is indicative of the speed at which the signal is transmitted. The lower the baud rate, the slower the signal (and the more expensive the phone bills).

d. Timing

- i. Synchronous: A method of signal transmission in which each element of the signal is sent at a predetermined time interval.
- ii. Asynchronous: A method of signal transmission in which each element of the signal is sent upon completion of the previous element.

- D. Interface Boards: Every peripheral device you use with your computer must have a receptacle in the computer to plug it into. If this receptacle is not built into the computer, you will have to buy an interface board to accomplish this purpose. (see below)

1. RAM Expansion: This will allow you to expand the memory of the computer. RAM stands for Random Access Memory; this is the amount of memory available for your programs.

2. **Printer**
 - a. **Serial Interfaces:** Boards that process signals in which each element of the signal is sent sequentially.
 - b. **Parallel Interfaces:** Boards that process signals in which the elements of the signal are sent in groups of 8 (or 16, or 32, depending on the type of computer).
3. **Disk Drive:** If you are contemplating a hard disk drive, you should be aware of one consideration that is not readily apparent. Corvus Systems (a brand name) puts out two configurations of hard disk systems. The Constellation system limits the placement of each computer to a radius of 50 feet from the hard disk. The Omninet package permits a radius of 4000 feet. I'm not sure if this is peculiar to Corvus or if a similar situation occurs with other hard disk systems, but it definitely is an issue to ask about.
4. **Modem:** Usually requires a serial board.
5. **80 Column:** If your computer only allows a display of 40 characters in width and you would like to display 80 (for word processing, let's say), you'll need an interface board to do this. One note: Color monitors often produce displays that are unreadable when they are 80 characters wide. Make sure you see what you'll be getting before you buy.
6. **Graphics:** Plotters, pads and tablets require interface boards.
7. **DAC:** These are boards that convert analog signals to digital ones. Analog signals are continuous over a given range, and digital signals occur in discrete chunks over that range. A watch with a sweep second hand is an analog device -- it moves smoothly and continuously from one second to the next -- while a digital watch displays each second as a discrete entity. The computer is a digital device, so when it wants to interpret or send out an analog signal (eg, music, voice, readings from scientific instruments) it needs an interface board to accomplish this end. NOTE: Game paddles, joysticks, and mice are analog devices. If your computer has a game paddle port, you may be able to use this instead of buying an interface board. Ask if this is possible.
8. **Operating System/Terminal Emulation:** Sometimes you may want your computer to act like another brand. (When you own an Apple and would like to run an IBM compatible program, for example.) You can buy boards that will give you this capability, but they are expensive and may not be 100% compatible with the software you want to run. Again, look before you buy.
9. **Real Time Clocks:** If you want to use the computer as a time clock, or to measure reaction times in psychology experiments, and the like, you will need an interface board that will allow the computer to keep time.
10. **Voice I/O:** Another example of an analog situation that you may want to use the computer for.

SOFTWARE SELECTION

For a thorough discussion of software evaluation, see "EVALUATING INSTRUCTIONAL SOFTWARE FOR DEVELOPMENTAL EDUCATION" by Curtis Miles (Academic Dean at Piedmont Technical College, Greenwood SC 29646), published by the National Association for Developmental Education (NADE).

- I. Meet Needs of Learners: Good software does more than present content clearly in a non-insulting manner. It should meet the needs of the learner, and very often the student that comes to the Learning Center has specific educational needs. As a simple example, consider the case of the program that uses animated graphics. The traditional student may find this rewarding, but to a highly distractible student with a short attention span this may be detrimental.

A. Learning Characteristics of Developmental Student

1. High Distractibility: Does the program use attention focusing devices such as sound, color, highlighting or flashing? Are these devices overused?
2. Short Attention Span: See #1 above.
3. Weaknesses In One Or More Learning Modality: Does the program attempt to use more than one "channel into the kid's brain"? Cater to more than one learning style?
 - a. Visual-Orthographic
 - b. Visual-Iconic
 - c. Auditory
 - d. Kinesthetic
 - e. Tactile
4. Weakness In Comprehension And Reasoning Skills: What does the program assume about this aspect of the learner?
 - a. Synthesis
 - b. Analysis
 - c. Generalization
 - d. Inference
 - e. Analogy
5. Inattention To Detail: See #1 above.
6. Inability To Follow Directions: See #1 above. Also, do the directions remain on the screen long enough? Is the screen cluttered?
 - a. Written
 - b. Oral
7. Poor Figure-Ground Differentiation: Is the screen uncluttered? Are diagrams clearly drawn? Does color enhance or distract from the diagrams?
8. Abstraction Of Thought: Developmental students are often concrete thinkers. Does the program progress from the concrete to the abstract?
9. Vocabulary: Will your students have trouble understanding the general and technical vocabulary in the program?

10. Fund Of General Knowledge: Does the program assume that your students know specific facts and have had certain experiences (eg., the number of feet in a mile, or a visit to a science museum)?
11. Short Term Memory: Does the program provide for enough drill and practice?
12. Independence Of Learning: Developmental students traditionally are dependent learners who are afraid to take risks and who need frequent reinforcement that they are on the right track. Does the program attempt to reduce these sources of anxiety?
13. Impulsive Learning Style: Will the program crash because the student hits the wrong key?
- B. Content: Is it appropriate? Does it follow your curriculum?
- C. Age/Grade level: Is the program insulting to a college student?
- D. Assumed Knowledge
 1. Of Content
 2. Of Computer: Does the program assume the student knows how to use the computer?

II. Unique Properties Of Computer: Good programs make use of those characteristics of the computer that other educational tools do not have.

- A. Random Generation: This will provide a nearly infinite source of randomly generated problems, rather than draw from a fixed pool of problems.
- B. Graphics, Animation: Does it help explain the material? Is it relevant?
- C. Records Keeping: Does the program automatically keep records of student progress? How sophisticated are these records? For example, do they just give a percentage or do they supply student answers?
- D. Interaction, Feedback: Is the feedback merely a yes or no, or does the program supply additional information when a wrong answer is given? Is the information supplied new, or does the program just loop back into information presented earlier?
- E. Continuous Individualization: Does the program adjust the speed of presentation or level of difficulty according to the accuracy and speed of the student's previous responses?
 1. Time: How long does the student have to respond?
 2. Difficulty
 3. Looping, Branching: Are explanations of incorrect responses built into the program?

III. Conditions Of Learning: Some programs that would be unsuitable for individual use may be acceptable if the student can work on the program with someone else. How will your students be using the programs?

- A. Working On Own
- B. Working In Small Group
 1. With Other Student
 2. With Tutor
 3. With Teacher

MICROCOMPUTERS IN THE LEARNING CENTER
THE PLANNED APPROACH

Now that you have all this information available to you the thing to do is analyze what you do in the Learning Center and what you want to do. That is what the following series of questions is designed to elicit. Once you have identified those functions you will be able to use this information to help you with a purchasing plan that is relatively error free.

- I. What do I do in the Learning Center?
 - A. Basic Skills Remediation
 - B. Classroom Supplement
 - C. Tutoring
 - D. Special Population Services
 - E. In-Services
 - F. Records Keeping
 - G. Correspondence
 - H. Default Services
- II. How do I deliver my services?
 - A. Individual Tutoring
 - B. Group Tutoring
 - C. Labs
 - D. Classes
 - E. A/V Services
- III. What special populations do I serve?
 - A. Academically Underprepared
 - B. Culturally Deprived
 - C. Learning Disabled
 - D. Physically Handicapped
 - E. Honors
 - F. Faculty
- IV. What priorities do I have for the above concerns?
 - A. Time spent in each activity.
 - B. Money spent on each activity.

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